Traditional and non-traditional technologies to address water data gaps in small-scale irrigation in Africa

Session II.
Improving water-efficient irrigation: Prospects and difficulties of innovative technologies and practices in agricultural water management

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PART I.

Measurement technologies and data acquisition to establish discharge history in traditional irrigation schemes in Burkina Faso and Uganda

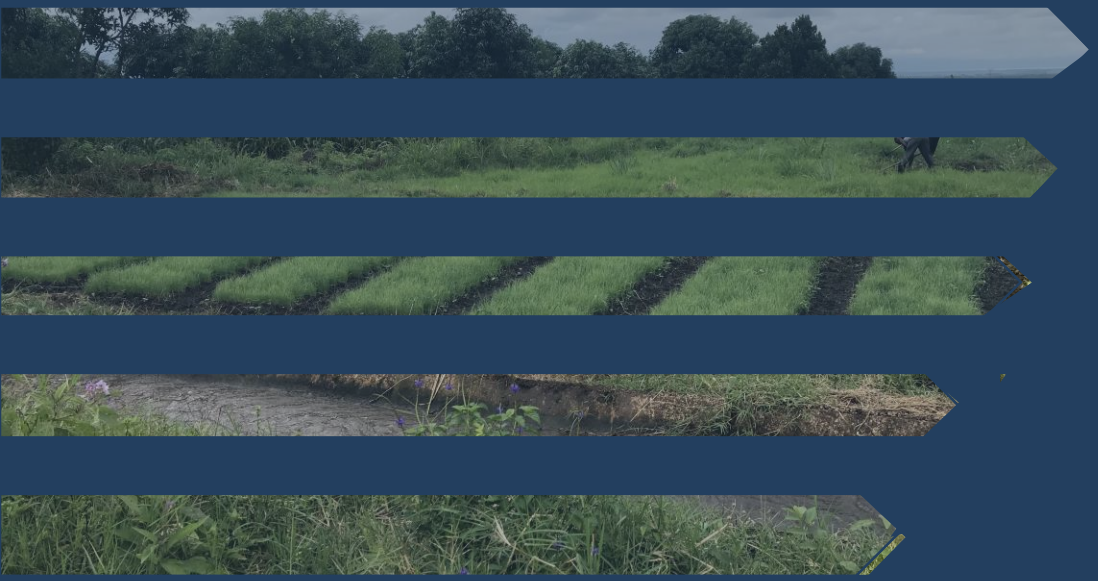
OUTLINE

Objectives and criteria for discharge measurement techniques

Discharge data collection protocol

Overview of technologies and data acquisition in Burkina Faso and Uganda

Objectives and criteria for discharge measurement techniques



Maximize the effective use of available water supply

Reduce the environmental impact

Maximize the field potential

Reduce the risk of nutrient-leaching

Objectives and criteria for discharge measurement techniques

Water Use Efficiency:
"…to find optimal water allocation to enhance water use efficiency."

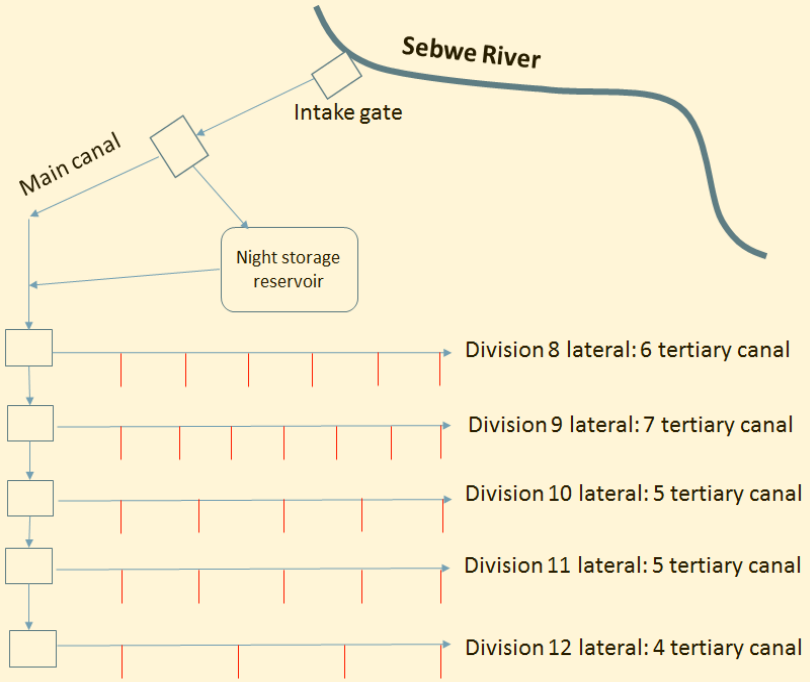
Water Productivity:
"…to find relation of water supply and crop water productivity."

Criteria

High accuracy		Reliable data collection protocol	Highly scalable
Consistent	Easy to use and access	Low cost	

Objectives and criteria for discharge measurement techniques

Map the system



Find key persons

Define the purpose of measurement

Install technology

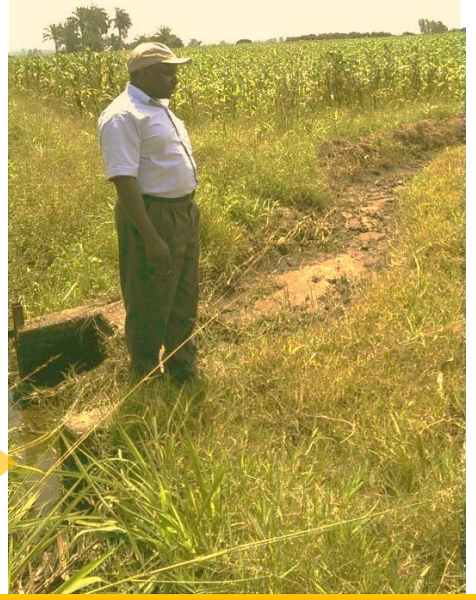
Pilot the method

Detect measurement accuracy

Fine-tune the method

Bring knowledge to management rules

Provide equity on farm level



Data collection protocol

Frequency and time criteria

- every day at the Main Canal, and only in the irrigation days of Divisions
- non-irrigation days excluded – not recorded in non-operating days
- in morning hours after opening the gates – but not immediately
- in the same period every day
- measurement with different techniques recorded in the same time
- one measurement per day recorded for control value, and another measurement for monitoring
- simultaneous recording in the scheme and within the Divisions

Criteria of order

- start at the Main Canal, followed by the secondary canal closest to the Main canal
- required stable flow (e.g. not right after opening the gates)
- reported invalid or violated measurement

Overview of technologies

Ben Nafa Kacha – Burkina Faso

- Water withdrawal: large-pump system
- Irrigation method: surface irrigation
- Secondary and tertiary level
- Measurement structure: modules a masques

Mubuku – Uganda:

- Water withdrawal: gravity
- Irrigation method: surface irrigation
- Secondary, tertiary, quaternary level
- Measurement structure: weir, large-scale particle image velocimetry

Burkina Faso

Ben Nafa Kacha irrigation scheme

Burkina Faso – Ben Nafa Kacha irrigation scheme

"Modules a masques"

- free surface water intake devices to supply controllable constant flow rate
- mono-block metal assemblies that are sealed to the canals
- flow rate can be adjusted by opening or closing the sliding gates
- 4 standardized types of different dimensions:
  - Series X: 10 l/s/dm or 1 l/s/cm
  - Series XX: 20 l/s/dm or 2 l/s/cm
  - Series L: 50 l/s/dm or 5 l/s/cm
  - Series C: 100 l/s/dm or 10 l/s/cm

Overview of technologies – modules a masques

Secondary Canal

to	Design Max Discharge (l/s)	Measured Discharge (l/s)
SC-1	150	238
SC-2	90	139
SC-3	150	139
SC-4	150	Missing
SC-5	150	119
SC-6	150	104

Tertiary canal

from	Design Max Discharge (l/s)	Measured Discharge (l/s)
SC-1	30	25 - 44
SC-2	30	13 - 32
SC-3	30	18 - 33
SC-4	30	31 - 39
SC-5	30	29 - 41
SC-6	30	33 - 41

Data acquisition - Modules a masques

3 Archimedes' screw operated by 3 large pump with 900 l/s total capacity

Manual control panel to record the opening and closing time

Calibrated modules a masques at secondary level controlled manually by the WUA

Calibrated modules a masques at tertiary level controlled manually by the farmers after irrigation rotation

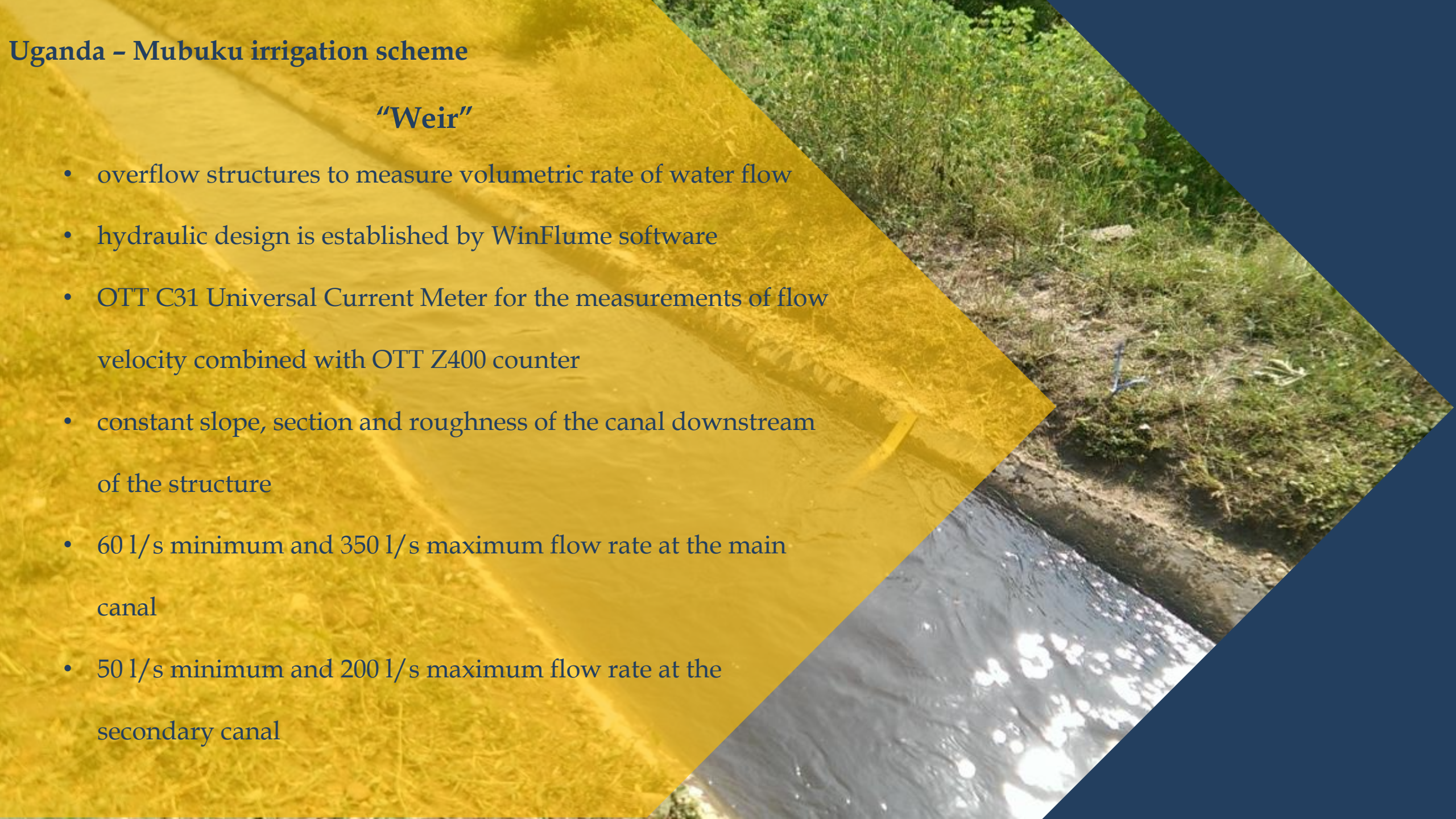
Uganda

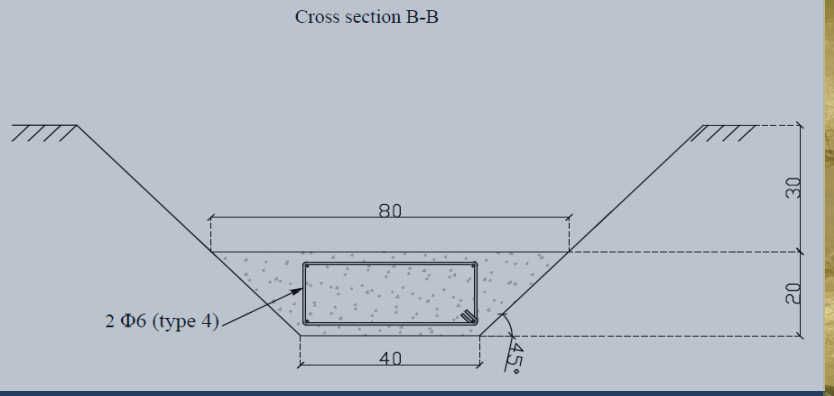
Mubuku irrigation scheme

Uganda – Mubuku irrigation scheme

“Weir”

- overflow structures to measure volumetric rate of water flow
- hydraulic design is established by WinFlume software
- OTT C31 Universal Current Meter for the measurements of flow velocity combined with OTT Z400 counter
- constant slope, section and roughness of the canal downstream of the structure
- 60 l/s minimum and 350 l/s maximum flow rate at the main canal
- 50 l/s minimum and 200 l/s maximum flow rate at the secondary canal





Measured with water level gauges

Water level

Discharge value

Measured with flow meter at a point in time

Derived from stage vs. discharge measurements over time at cross-section

Rating curve

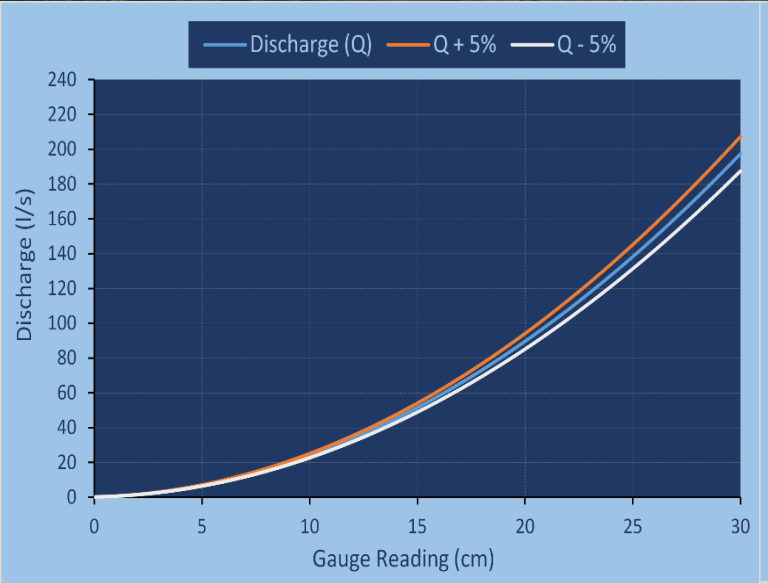
Discharge time-series

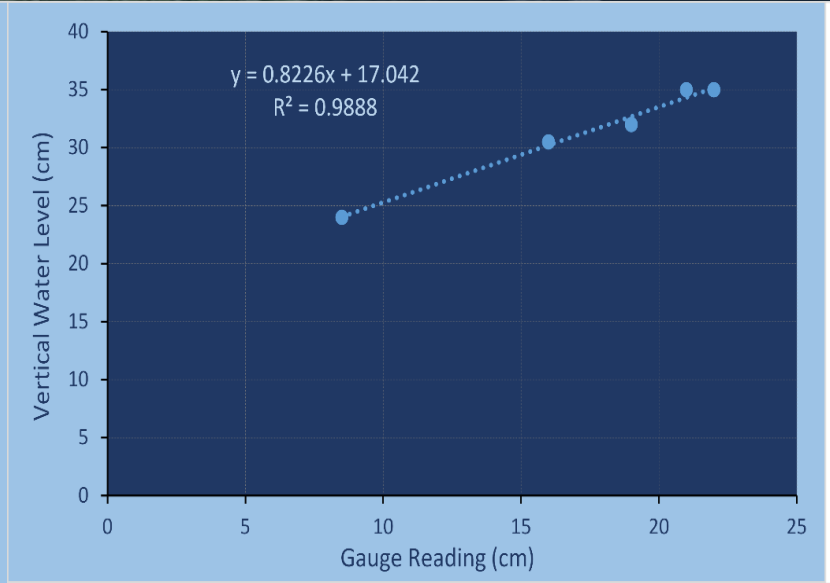
Apply rating curve to convert stage height to discharge time series

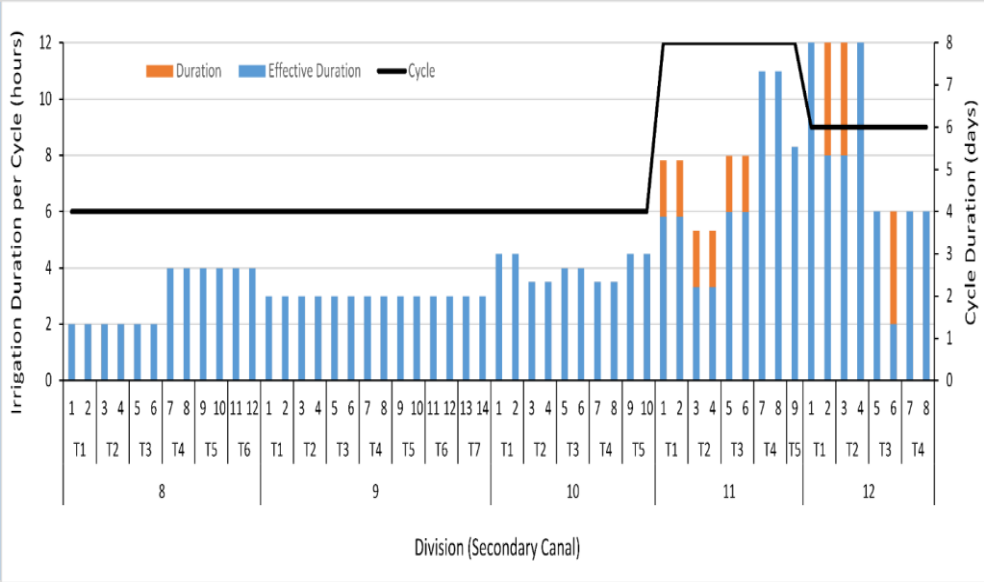
Data acquisition

Weir

Established rating curve by calibration → Measured accuracy by validation → Manual gauge measurement according to the irrigation schedule







Uganda – Mubuku irrigation scheme

"LSPIV"

- Large Scale Particle Image Velocimetry: indirect measurement by recording continuous images of the flow surface
- mobile app capable of separating the moving image content from the stationary image
- cross-correlation algorithm to determine the most likely displacement of patterns
- working for different open-channel conditions (e.g. light conditions, turbidity of water, materials of the channel)

Canal characteristics

Define the cross-section, marker and roughness of the canal bed while ensuring constant flow – no backwater effect

Location and devices

Find place for the markers in an easily accessible place, set your camera accordingly

Flow visualization

Use the application to record video with the following requirements: sufficient flow seeding (tracers), optimal illumination, high resolution camera setting, oblique angle to surface plane

Scale-out and scale-up

Evaluate dataset on management level for optimal water allocation
and
Train stakeholders to ensure understanding and more frequent monitoring

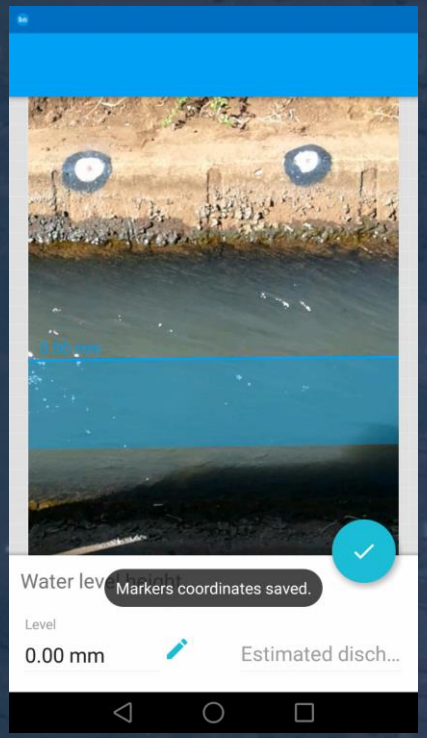
Establish discharge history

Collect discharge data according to the data collection protocol to obtain comprehensive dataset for evaluation

Image processing

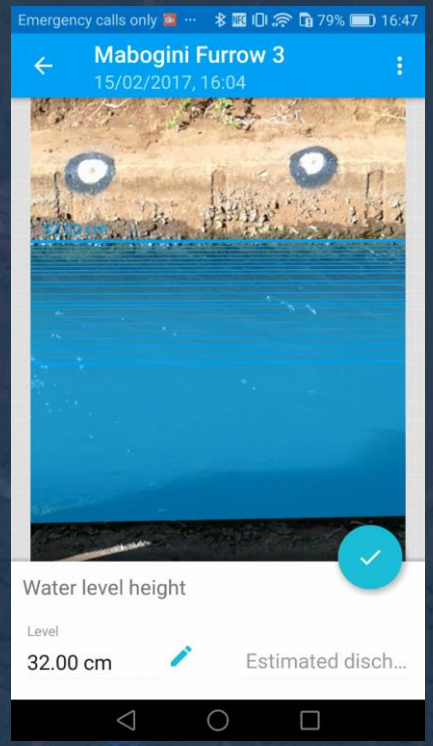
Pattern matching technique process the images through image velocimetry algorithm (cross-correlation between interrogation areas)

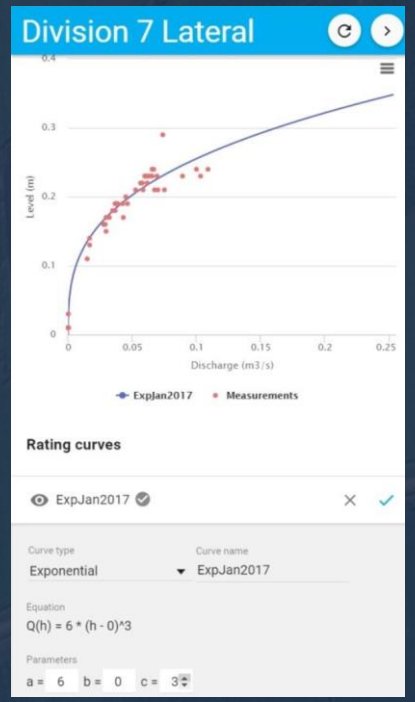
Data acquisition - LSPIV



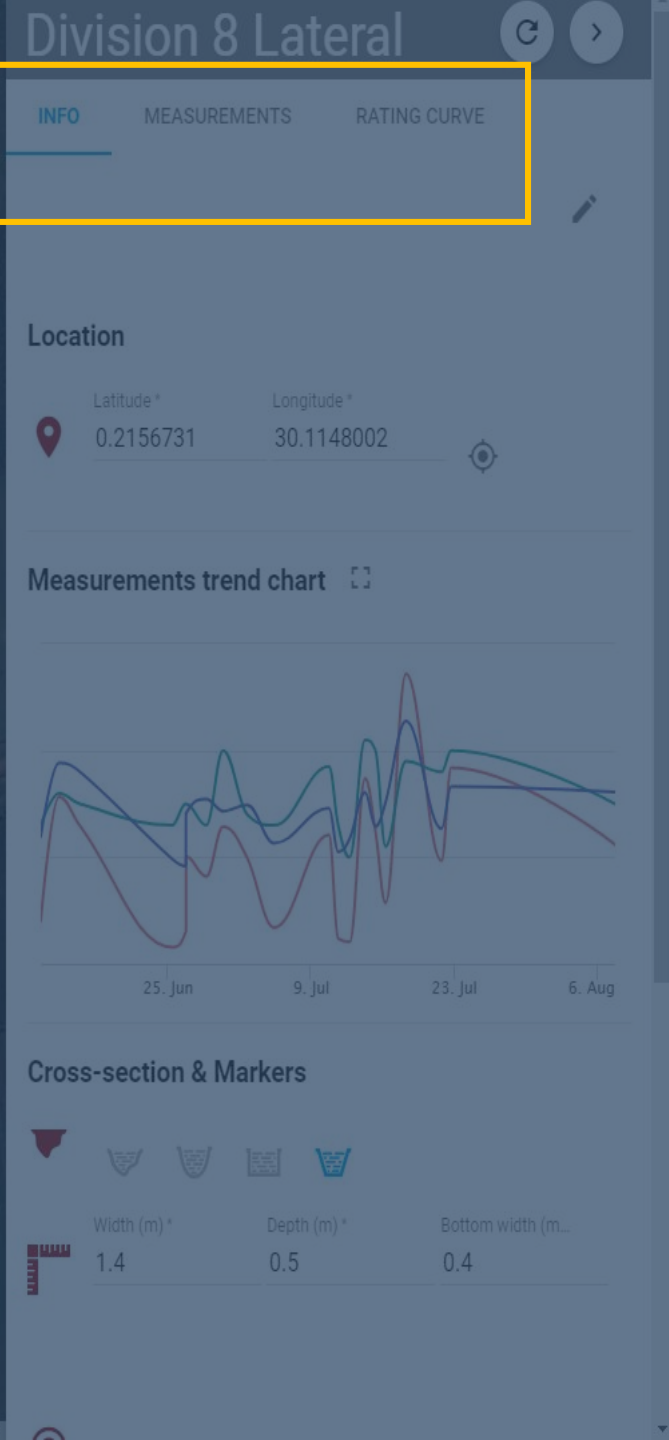
Video - video recording

Video – image processing





Data acquisition by gauge measurement




Thanks our Colleagues in Uganda for their hard work!